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LATE GLACIAL–HOLOCENE EVOLUTION OF THE WĄTOK STREAM VALLEY IN TARNÓW GUMNISKA SITE, SOUTH POLAND

Abstract. Geological studies carried out in the Wątok stream valley at the foreland of the Carpathian Foothills concentrated on an alluvial sequence composed of coarse-grained gravels and sands, organic sediments and overbank silts. This sequence originated during the Vistulian Late Glacial and Holocene times, as indicated by palynological analysis and radiocarbon dating of organic sediments at Tarnów Gumniska, as well as by comparison with similarly developed alluvial sequences in the Wisłoka valley and in the Jasło–Sanok Depression.

Key words: pollen succession, Late Glacial, Holocene, Tarnów Gumniska site, Wątok stream valley, foreland of the Carpathian Foothills

INTRODUCTION

The first description of lithology and age of sedimentary infill of the Wątok stream valley was given by L. Starkel (1960) who suggested a Late Glacial–Holocene age of the more than 10 m thick alluvial sequence basing on plant remnants identified by M. Wąs.

During detailed geological mapping of the Wola Rzędzińska sheet (S. Brud, in print, *Szczegółowa Mapa Geologiczna Polski — Detailed Geological Map of Poland*), in the SE part of the city of Tarnów, Gumniska quarter (Fig. 1), an analysis of archival borehole and shallow well logs revealed the presence of organic intercalations (peat, organic muds) within sediments of the higher terrace of the Wątok stream, a right-hand tributary of the Biała river. This stream, whose catchment area is ca 71 km^2, according to L. Starkel (1999) belongs to transitional streams between large rivers, like Dunajec or Wisłoka, and small brooks that dissect the Carpathian Foothills margin. Unlike large rivers of this area, the Quaternary history of the Wątok stream has not been dealt with in detail.

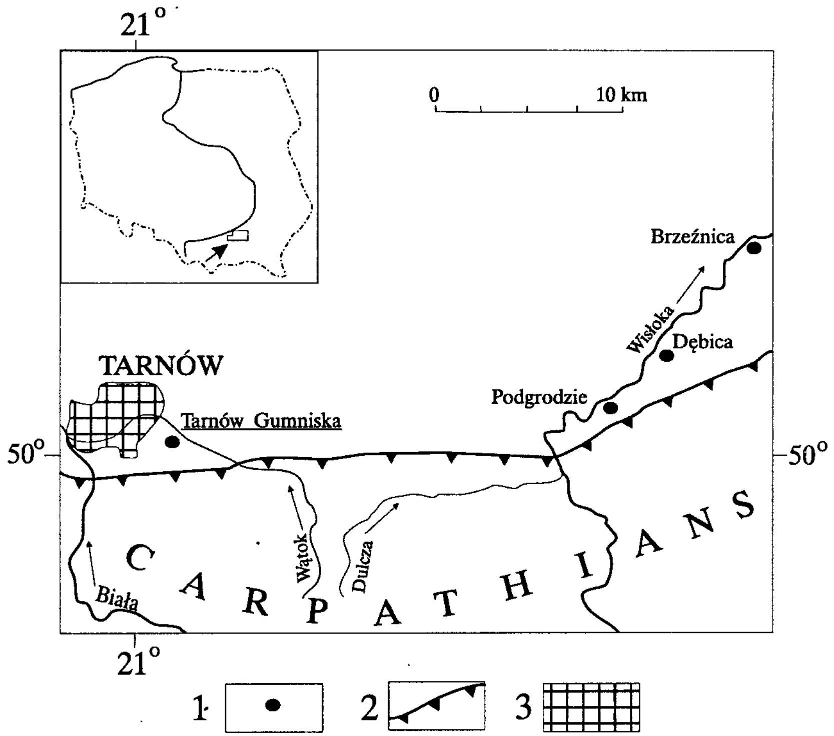

Fig. 1. Location of the study area in southern Poland. 1 — location of sections mentioned in the text, 2 — Carpathian frontal thrust, 3 — city of Tarnów

GEOMORPHOLOGICAL AND GEOLOGICAL SETTING

The upper course of the Wątok stream is situated in the Carpathian Foothills, its lower reach, where the stream turns towards west, which is dealt with in this paper, belongs to the Tarnów Plateau (Fig. 1). The valley studied is incised into the Sanian 2 (Elsterian 2) glacial sediments and underlying Miocene clayey strata (Fig. 2).

In the Tarnów Gumniska area, the Wątok stream cuts into Miocene strata down to 200–190 m a.s.l., and its valley bottom is occupied by 4.5–5.5 m terrace steps and 1.5–3.5 m flood plain (Fig. 3).

The lowermost part of the sedimentary sequence of the higher (situated above flood plain) terrace, reconstructed on the basis of more than 40 archival borehole logs, is composed of dark-grey gravels and sands with gravels, locally underlain by grey sands, and its thickness varies from 2 to at least 7 m. The gravels are nearly exclusively composed of Carpathian flysch-derived sandstones, a few per cent only being built of siliceous rocks. These gravels are covered by fining-upwards sands and silts. In the Tarnów Gumniska area a few boreholes pierced through organic sediments described as peat or organic muds, occurring at a depth

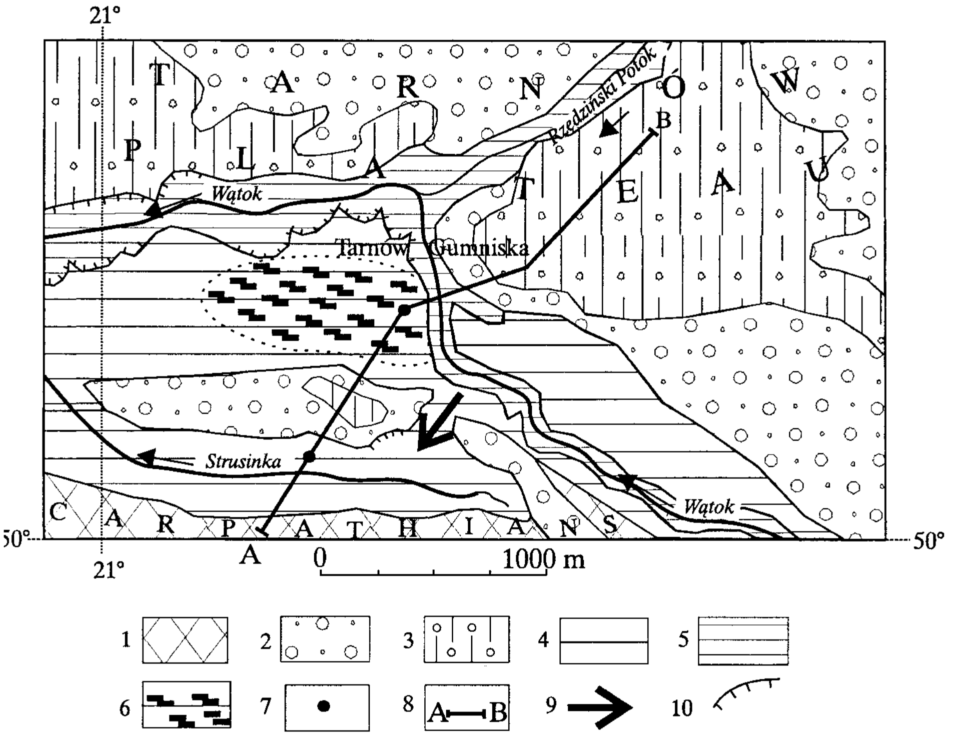

Fig. 2. Simplified geological sketch of the Tarnów Gumniska area (after S. Brud, in print). Miocene: 1 — clays, sands and silts; Quaternary: South Polish Glaciations (Sanian 2): 2 — glaciofluvial vari-grained gravels and sands, 3 — till; Holocene: 4 — alluvial fines, peaty muds, peats, sands and gravels of the 4,5–5,5 m high terrace, 5 — muds, sands with gravels of the 1.5–3.5 m high flood plain, 6 — extent of buried peats, 7 — location of logs dated by ^{14}C and palynological method, 8 — A–B — geologic cross-section (see Fig. 3), 9 — probable location of Wątok flow, 10 — edge of escarpment

of 2.8 to 6.0 m (Fig. 2). The distribution of organic sediments suggest that there was likely a swampy flood plain. The peat deposits were in the range of constant floods and delivery of suspended matter. A recently drilled borehole confirmed the occurrence of these sediments (Fig. 4) which were sampled for palynological analysis and radiocarbon datings. The latter gave an age of 8,380 ± 160 years BP (Gd–10,858) for the lower part of organic strata. Organic sediments are overlain by laminated sandy silts which pass higher upwards into massive alluvial silts. The whole sequence is more than 4.5 m thick (Fig. 4).

The flood plain terrace in the upper course of the Wątok stream forms narrow benches composed of coarse-grained sands with gravels and fines. Downstream of the confluence of the Rzędziński stream and Wątok stream, the flood plain broadens to several hundred metres, and its surface is marked by abandoned channels. This terrace is cut into sediments of the higher terrace, and lithological character of its alluvial cover differs from that of the higher terrace: coarse-grained sediments are here overlain by 2-m-thick fines.

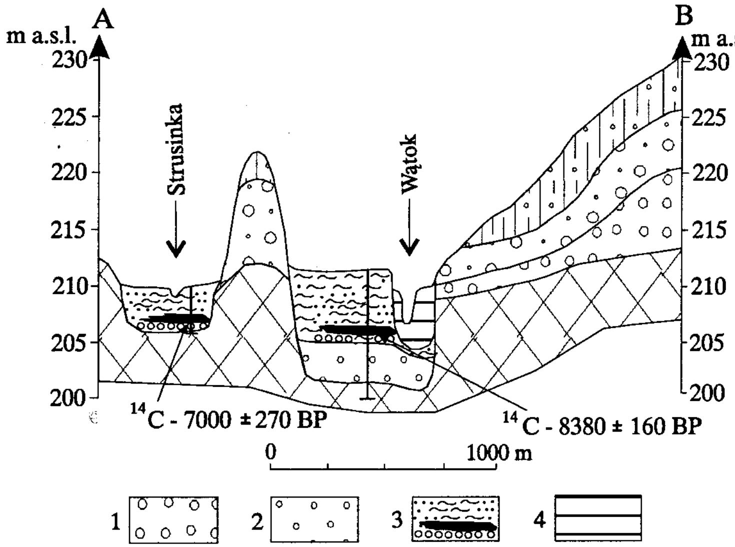

Fig. 3. Geologic cross-section A–B of the Wątok and Strusinka stream valleys near Tarnów Gumniska. Quaternary: Pre-pleistocene (?): 1 — coarse-grained gravels and sands; Pleistocene: Vistulian Glaciation: 2 — fluvial gravels and sands; Holocene: 3 — alluvial fines, peaty muds, peats, sands and gravels of the 4.5–5.5 m high terrace, 4 — sands with gravels, muds of the 1.5–3.5 m high flood plain. For other explanations see Fig. 2

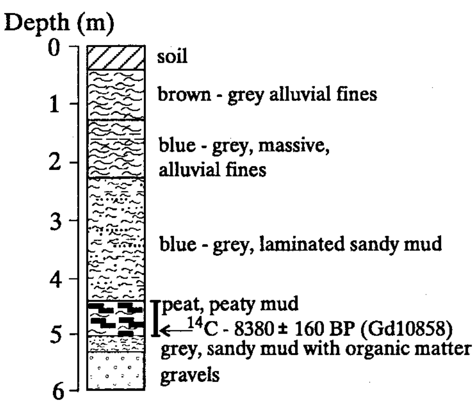

Fig. 4. Borehole of Tarnów Gumniska. I — interval analysed by palynological and ^{14}C methods

South of the Wątok stream valley a vast, tectonically controlled morphological depression occurs, being presently drained by the Strusinka stream (Fig. 2). The top of Miocene strata (205–200 m a.s.l.) is here higher than in the Wątok stream valley and the thickness of sedimentary cover does not exceed 4.0 m. The base of this cover is composed of thin sandy-gravel layers, overlain by clayey muds with organic intercalations (radiocarbon dated at 7,000 ± 270 years BP; Gd–9,965) and alluvial fines (Fig. 3). This depression was probably drained by the Wątok stream whose channel underwent avulsions, surrounding from

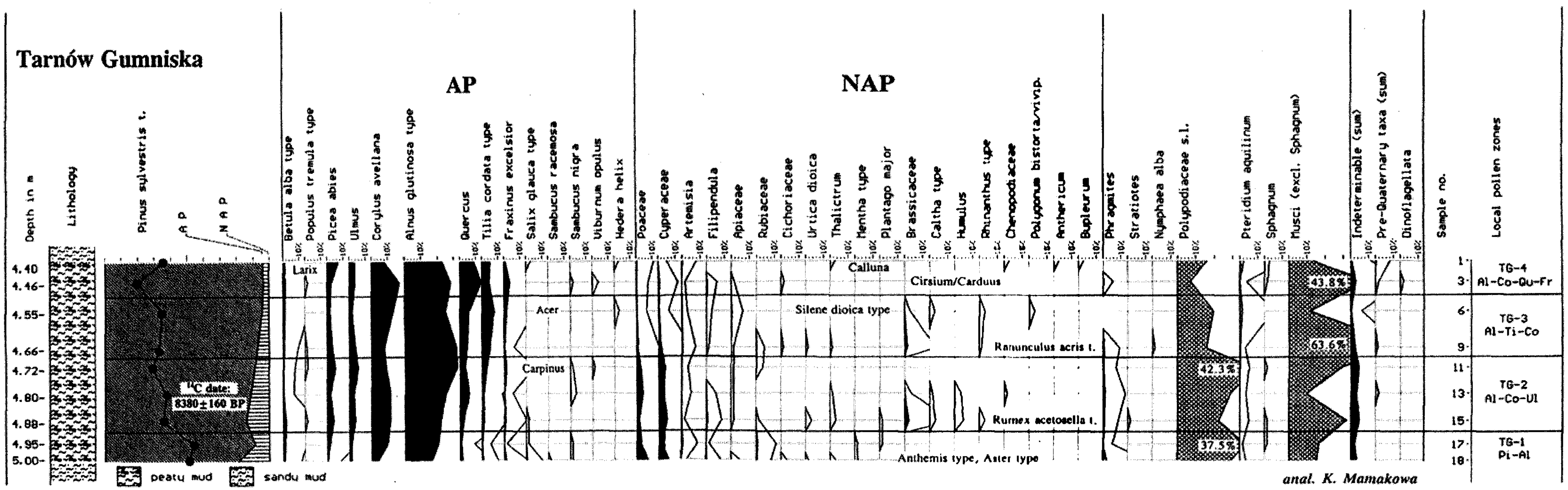

Fig. 5. Tarnów Gumniska, percêntage pollen diagram

the south remnant hills built up of Miocene strata overlain by glacial sediments. These avulsions are marked by erosional scarps and a fossil furrow in between the hills, filled with 4-m-thick alluvia (Fig. 2).

RESULTS OF POLLEN ANALYSIS

The pollen succession (Fig. 5) of the 60-cm-thick layer of peaty muds of the Wątok 4.5–5.5 high terrace at Tarnów Gumniska has unambiguosly shown that the sediment was deposited in a warm period. The obtained fragment of the pollen succession is represented by four local pollen assemblage zones (L PAZ): TG–1 *Pinus-Alnus*, TG–2 *Alnus-Corylus-Ulmus*, TG–3 *Alnus-Tilia-Corylus* and TG–4 *Alnus-Corylus-Quercus-Fraxinus*.

The lower zone — TG–1 *Pinus-Alnus* — indicates that the beginning of sedimentation took place when pine communities, perhaps with scarce trees of spruce and birch, were predominating in this region and alder wood, probably mostly with black alder (*Alnus glutinosa*), grew in the Wątok valley. The continuous curves of *Ulmus* and *Fraxinus* pollen point also to the occurrence of patches of elm-ash riverine communities on wet habitats. At the edges of woods and in their understorey, especially on drier habitats, hazel was of significant importance.

Relatively high values of herbaceous pollen (NAP) allow us to conclude that these woods were not fully closed and in the stream valley numerous habitats were most likely occupied by herb communities. Locally, the fern-reed community with a large proportion of mosses was quite important.

In the next zone TG–2 *Alnus-Corylus-Ulmus* at the level dated by ^{14}C at 8,380 ± 160 BP (Gd–10,858), the pollen values of *Alnus* t. *glutinosa* attain 25.2%, *Corylus* — 11.7%, *Quercus* — 5.9%, *Ulmus* — 3.2%, and *Tilia* t. *cordata* — 1.2%. Above the dated level all these trees and *Corylus* reach higher percentages.

Changes in the pollen succession, represented by the zone TG–2 *Alnus-Corylus-Ulmus*, and subsequent zones TG–3 *Alnus-Tilia-Corylus* and TG–4 *Alnus-Corylus-Quercus-Fraxinus*, point to a declining role of pine forests and to successively increasing expansion of *Alnus, Ulmus, Tilia, Quercus, Picea, Fraxinus* and *Corylus avellana*. The above changes show that this area was overgrown with various communities of deciduous and mixed forests. They were becoming more and more closed which is evidenced by a consequent decrease of herb pollen values in the two top pollen zones, down to 4–3%. Pollen of *Hedera helix* indicates the increasing oceanicity of the climate with mild winter season at the time.

Comparison of recent pollen-analytical results of the Tarnów Gumniska section with other Holocene pollen diagrams from this part of Poland, especially with those located near Dębica (Fig. 1), i.e. at Podgrodzie (Mamakowa and Starkel 1977; Alexandrowicz et al. 1981) and Brzeźnica (Mamakowa and Starkel 1974; Kowalkowski et al. 1981), as well as with the sites from the Jasło–Sanok Depression (Harmata 1987, 1995), allows us to suppose that the date 8,380 ± 160 BP in the Tarnów Gumniska log is probably a little bit rejuvenated. Similar ^{14}C dates (8,390 and 8,370) occur at Podgrodzie above the recorded increase of *Tilia* pollen values, whereas at Tarnów Gumniska the date 8,380 is found below that increase.

Comparison of the beginning of the pollen succession of Tarnów Gumniska with the data from the Podgrodzie section, as well as with those from the Jasło–Sanok Depression sites, for which numerous radiocarbon dates are available, allows us to infer that the beginning of peaty mud deposition in Tarnów Gumniska could have taken place ca 8,800 BP, and a break in the peatbog development occurred ca 8,000 BP. Thus, the deposition period was placed in the younger part of the Boreal and in the older part of the Atlantic (see the proposed division for the Wisłoka river valley by Starkel 1981).

DISCUSSION AND CONCLUSIONS

The presence of thick series of coarse-clastic sediments in a deeply incised (at least 11 m) valley of the Wątok stream testifies to intensive erosion followed by aggradation of sediments by an high-energy river. These gravels were probably deposited in Late Glacial times. Such a conclusion is based on a comparison of data collected in the Wątok stream valley with those of sedimentary sequences occurring in the Vistula river valley and its right-hand tributaries (Starkel and Gębica 1992; Starkel 1995; Kalicki 1997), where sedimentation of clastic sediments is considered to have been confined to the coolings of Older and Younger Dryas. However, in small tributaries of the Vistula river, deposition of organic sediments started already in the Late Glacial what is documented by results of pollen analysis and ^{14}C datings (Kalicki 1997). The lack of Late Glacial and Early Holocene organic sediments in the Wątok stream valley allows us to suppose that deposition of coarse-clastic material took place here in the Late Glacial and may be continued in the Early Holocene. Sandy muds with organic intercalations underlying organic sediments (Fig. 4) probably represent also the beginning of the Holocene.

Results of pollen analysis (Fig. 5) and radiocarbon dating of organic sediments of the higher terrace of the Wątok stream, as well as a comparison with other sections indicate that deposition of these sediments occurred between 8,800 and 8,000 years BP, i.e. in the younger part of the Boreal and the older part of the Atlantic. Development of forests both in the Carpathian Foothills and in the Wątok stream valley limited the supply of mineral material to the oxbow lake which gradually became filled with organic sediment.

Biogenic deposition terminated in the early Atlantic, being later replaced by aggradation of laminated sandy muds with traces of organic matter. These sediments are more than 2 m thick, suggesting frequent repetition of flooding cycles which prevented pedogenic processes from obliterating original lamination. This conclusion is compatible with L. Starkel's (1994) observations from the upper Vistula drainage basins. Big floods during the Holocene could be also suitable for the Wątok channel avulsions, i.a. into the Strusinka valley. However, this valley could be only flooded by freshet of Wątok and filled with its fines. Such supposition is based on ^{14}C dating of its organic sediments to 7,000 ± 270 years BP (Fig. 3). In the light of these data, F. Pulit's (1975) conclusion about Eemian age of river piracy and channel avulsions of the Wątok stream into the Strusinka valley cannot be confirmed.

Deposition of massive alluvial fines both in the Wątok and Strusinka stream valleys may reflect increased frequency and energy of floods in this area. These processes were most likely associated with human activity, deforestation and with the development of agriculture in historical times. The lack of sedimentological studies, however, makes it difficult to discriminate between natural (climatic) and anthropogenic influences upon sedimentation of this part of the alluvial sequence.

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STRESZCZENIE

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PÓŹNOGLACJALNA I HOLOCEŃSKA EWOLUCJA DOLINY POTOKU WĄTOK — STANOWISKO TARNÓW GUMNISKA, POLSKA POŁUDNIOWA

Badania sytuacji geologicznej w dolinie potoku Wątok, w części należącej do Płaskowyżu Tarnowskiego wykazały, że typową sekwencję aluwialnych osadów reprezentują tu gruboziarniste żwiry i piaski, osady organiczne i pokrywa mad pylastych.

Wyniki analizy pyłkowej osadów organicznych z terasy nadzalewowej potoku Wątok o wysokości 4,5–5,5 m, ze stanowiska w Tarnowie Gumniskach, datowanie dolnej części tych osadów na 8380 ± 160 BP (Gd–10858) oraz porównanie tych danych z wynikami badań w dolinie Wisłoki koło Dębicy i w Dołach Jasielsko-Sanockich pozwoliły na stwierdzenie, że osadzanie osadów organicznych w dolinie Wątoka miało miejsce w młodszej części okresu borealnego i starszej okresu atlantyckiego (ca 8800–8000 lat BP).

Porównanie sekwencji osadów aluwialnych w dolinie potoku Wątok z seriami aluwialnymi w dolinach innych rzek z terenu przedpola Karpat wykazało, że seria ta zaczęła się tworzyć w zimnym okresie ostatniego zlodowacenia i formowała się aż do czasów historycznych.